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Evaluation of Noise Level of Refrigeration Equipment

Army Natick Laboratories

JANUARY 1972

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13. ABSTRACT This report covers an evaluation of the gasoline-engine-driven 3000 Btu/hr capacity, 5000 Btu/hr capacity, and 9000 Btu/hr capacity refrigeration units to establish noise levels during operation for the conditions: as manufactured, after addition of a muffler, and after application of acoustical material. The objectives of the evaluation were a Determine the noise level at the operator's position for each of the units as manufactured, after addition of a muffler, and after application of two types of acoustical material b Determine the distances in front of, to the left, and to the right of each unit to the 90-decibel noise level c Determine the back pressure in the exhaust manifold of each unit after assembly of the various mufflers d Determine the levels of the octave bands for the 150-300, 300-600, 600-1200, 1200-2400, 2400-4800, and 4800-10,000 cycles per second bands at the operator's position for each of the refrigeration units in the various configurations. The data from the various evaluations establish that a The noise level at the operator's position for all refrigeration units in the various configurations exceeded the 90-dBC level specified in the DA TB MED 251, Noise and Conservation of Hearing b The distance to the 90-dBC level in front of the refrigeration units in the various configurations varied from 10 feet, 3 inches to 21 feet, 7 inches c The distance to the 90-dBC level to the left of the refrigeration units in the various configurations varied from 6 to 15 feet, 3 inches. d The distance to the 90-dBC level to the right of the refrigeration units in the various configurations varied from 3 feet, 7 inches to 18 feet, 8 inches. e The back pressure in the exhaust manifold of the refrigeration units after assembly of the various mufflers exceeded the 8 inches of water requirement in all instances. f The levels of the octave bands for the 150-300, 300-600, 600-1200, 1200-2400, 2400-4800, and 4800-10,000 cycles per second exceeded the decibel levels specified in Table J, DA TB MED 251, Noise and Conservation of Hearing. The addition of mufflers and the application of acoustical material, singly and in combinations, did not reduce the noise level and the levels of the octave bands to conform to the limits specified in DA TB MED 251, Noise and Conservation of Hearing.			

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Noise reduction	8					

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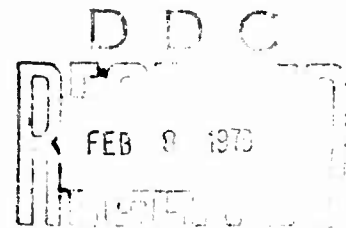
TECHNICAL REPORT

72-71-GP

EVALUATION OF NOISE LEVEL OF REFRIGERATION EQUIPMENT

by

Morris L. Budnick



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General Equipment & Packaging Laboratory

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EVALUATION OF NOISE LEVEL OF REFRIGERATION EQUIPMENT

1. Introduction:

It has been recognized that continuing exposure to loud noises may result in permanent impairment of hearing. This condition is a recognized physical disability under many laws in this country. Impaired hearing is a matter of significant concern to the military, as this condition may affect the combat efficiency of the individual soldier. Refrigeration equipment is used extensively by military personnel under varying conditions. The Surgeon General, to protect the military and to control noise pollution, imposed a noise-level limit on gasoline-engine-driven refrigeration units. The evaluation is the result of this action by The Surgeon General.

2. Objectives:

The objectives of the evaluation of refrigeration units were:

- a. Determine the noise level at the operator's position for refrigeration units as received.
- b. Determine the effect of the addition of a muffler and/or acoustical material on the noise level at the operator's position for the refrigeration units.
- c. Determine the back pressure in the exhaust manifold of each refrigeration unit after assembly of the various mufflers.
- d. Determine the distance in front of, to the left and to the right of the refrigeration units for the 90-decibel noise level.
- e. Determine the levels at the operator's position of the octave bands for the 150 to 300, 300 to 600, 600 to 1200, 1200 to 2400, 2400 to 4800, 4800 to 10,000 cycles per second bands for each refrigeration unit in the various configurations.

3. Test Items:

The 3000-Btu/hr capacity, the 5000-Btu/hr capacity, and the 9000-Btu/hr capacity refrigeration units were evaluated. The 3000-Btu/hr capacity refrigeration unit was manufactured to conform with Military Specification MIL-R-43031.¹ The gasoline engine is identified as Engine, Gasoline: Air Cooled, Industrial Type, 4 Cycle, Military Design, Model 2A016. The compressor conformed to Type I, MIL-STD-279.² The refrigeration unit as received had an open exhaust without a muffler.

The refrigeration unit was assembled to and operated with a 70-cubic foot refrigerator conforming to Military Specification MIL-R-43024.³

The 5000-Btu/hr capacity refrigeration unit was manufactured to conform with Military Specification MIL-R-12574.⁴ The gasoline engine was identified as Engine, Gasoline: Air Cooled, Industrial Type, 4 Cycle, Military Design, Model 2A016. The compressor conformed to Type I, MIL-STD-279. The refrigeration unit as received had an open exhaust without a muffler. The refrigeration unit was assembled to and operated with a 150-cubic foot refrigerator conforming to Military Specification MIL-R-12571.⁵

The 9000-Btu/hr capacity refrigeration unit was manufactured to conform with Military Specification MIL-R-10735.⁶ The gasoline engine was identified as a multicylinder, air cooled, 4 cycle, 7.1 brake horsepower at 1800 revolutions per minute, conforming to Group I, Military Specification MIL-E-11275.⁷ The compressor conformed to Type II, MIL-STD-279. The refrigeration unit as received was equipped with an Onan Muffler. The refrigeration unit was assembled to and operated with a semi-trailer refrigerator, series M349, Military Specification MIL-S-62034.⁸

4. Noise Level Requirement:

The maximum acceptable noise level at the operator's position for both the 3000 Btu/hr capacity and the 5000-Btu/hr capacity refrigeration unit was established in the latest revision of the applicable military specifications, MIL-R-43031 and MIL-R-12574, as ninety decibels on the "C" scale (90 dBC). Neither the 3000 Btu/hr capacity refrigeration unit nor the 5000-Btu/hr capacity refrigeration unit were designed or manufactured to conform to the 90-dBC noise level requirement. An acceptable noise level maximum was not specified for the 9000-Btu/hr capacity refrigeration unit.

5. Test Method:

The test methods for the 3000-Btu/hr capacity and the 5000-Btu/hr capacity refrigeration units were essentially identical. As stated, the 3000-Btu/hr capacity refrigeration unit was assembled to a 70-cubic foot refrigerator for the various evaluations. The 5000-Btu/hr capacity refrigeration unit was assembled to a 150-cubic foot refrigerator.

The refrigerator with the refrigeration unit in place was positioned on a flat outdoor space free of any buildings or reflecting surfaces for a distance of not less than fifty feet.

The surface was asphalt material and free of loose soil or snow. The level of the ambient noise was obtained to determine that the ambient noise level was at least ten decibels lower than the equipment noise level. The wind velocity was obtained prior to obtaining the equipment noise level. Noise level measurements were not taken when the wind velocity exceeded twelve miles per hour. A General Radio Company Model 1551-B Sound Level Meter was used to obtain the noise level at the operator's position and the distance for the 90-decibel levels in front of, to the left and to the right of the refrigeration units. A General Radio Company Model 1550A Octave Band Analyzer was used to obtain the noise level of the various octave bands. The General Radio Company Model 1551B Sound Level Meter reproduces within plus or minus two decibels. The decibel readings from the General Radio Company Model 1550A Octave Band Analyzer vary between one and three percent for the various bands, less than three decibels for the maximum condition. A point, two feet in the center and in front of the refrigeration unit, and four feet above the surface was established as the operator's position and the point to be used for the noise level readings of the octave bands. It was agreed at a meeting with Surgeon General personnel that this point is the approximate position of the more exposed ear of personnel who service and maintain the equipment.

To obtain the noise level at the operator's position, the 3000-Btu/hr capacity refrigeration unit with the open exhaust was operated at the rated load. The sound level meter was placed at the point designated as the operator's position and decibel readings obtained. The meter was moved until the 90-decibel reading was obtained. The distance from the 90-dBC point to the refrigeration unit was obtained and recorded. The "C" scale value was used because the limits by the Surgeon General in Department of the Army Technical Bulletin TB MED-251⁹ are specified in "C" weightings. The procedure was repeated to the left and to the right of the refrigeration unit. The sound level meter is positioned in both instances on the centerline through the unit. The octave band analyzer was placed at the designated operator's position, and decibel readings were obtained and recorded for the 20 to 75, 75 to 150, 150 to 300, 300 to 600, 600 to 1200, 1200 to 2400, 2400 to 4800, and 4800 to 10,000 cycles per second sound bands.

A Nelson Muffler, Number 1066, was added to the refrigeration unit. The refrigeration unit was operated at the rated load and the noise level at the operator's position, the 90-dBC distances, and the octave band data were obtained and recorded. In addition, a water manometer was connected to the exhaust manifold and back pressure readings were obtained and recorded.

The Nelson muffler was removed and a Hapco M39-1416 Muffler added. The refrigeration unit was operated at the rated load. The noise level at the operator's position, the distance for the ninety-decibel noise level, the noise level for the various octave bands, and the back pressure in the exhaust manifold were obtained and recorded.

The method to obtain data on the 3000-Btu/hr capacity refrigeration unit was used, essentially, to obtain data on the 5000-Btu/hr capacity refrigeration unit with the following exceptions: Two different Hapco mufflers and two types of sound absorbing acoustical material were evaluated. Noise level data was obtained and recorded of the unit with the open exhaust, after assembly of a muffler, with acoustical material behind and at the bottom of the area which contains the gasoline engine and the compressor, and with the various mufflers and acoustical materials used in combinations. Back pressure in the exhaust manifold after assembly of the various mufflers was obtained and recorded.

The evaluation of the 9000-Btu/hr capacity refrigeration unit was made with the unit assembled to a semi-trailer refrigerator less the tractor. The operator's position was a point two feet in front and center of the unit and eight feet above the surface. The semi-trailer and refrigeration unit were placed on a flat outdoor space free of buildings or any reflecting surfaces for a distance of not less than fifty feet. The refrigeration unit was operated at the rated load, and the noise level data at the operator's position, the distance to the 90-decibel noise level in three positions, and the noise level at the operator's position for the various octave bands were obtained and recorded.

6. Results: (Tables of test results will be found in Appendix B.)

The results of the noise level and back pressure tests of the 3000-Btu/hr capacity refrigeration unit with the open exhaust and with each of two different mufflers are detailed in Table I.

The results of the noise level and back pressure tests of the 5000-Btu/hr capacity refrigeration unit with the open exhaust and with each of three different mufflers are detailed in Table II.

The results of the noise level tests of the 5000-Btu/hr capacity refrigeration unit with the open exhaust and each of the two acoustical materials are detailed in Table III.

The results of the noise level tests of the 5000-Btu/hr capacity refrigeration unit with the Nelson Muffler No. 1066 and each of two acoustical materials are detailed in Table IV.

The results of the noise level tests of the 5000-Btu/hr capacity refrigeration unit with the Hapco M39-1416 Muffler and each of two acoustical materials are detailed in Table V.

The results of the noise level tests of the 5000-Btu/hr capacity refrigeration unit with the Hapco M39-1-S1 Muffler and each of two acoustical materials are detailed in Table VI.

The results of the noise level tests of the 9000-Btu/hr capacity refrigeration unit equipped with the Onan Muffler are detailed in Table VII.

The back pressure in the exhaust manifold of the 3000-Btu/hr capacity and the 5000-Btu/hr capacity refrigeration units after assembly of the various mufflers exceeded the eight inches of water specification requirement.

The noise level at the operator's position for each of the three refrigeration units tested as received, with a muffler, with acoustical material, and with a muffler and acoustical material varied from 99 dBC to 103 dBC, reference Figure 1. (See Appendix A.)

The noise level for the 3000-Btu/hr capacity refrigeration unit with the open exhaust exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 300 to 600, 600 to 1200, and 1200 to 2400 cycles per second frequency bands, reference Figure 2.

The noise level for the 3000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1056 and the Hapco Muffler M39-1416 exceeded the limits of the Department of the Army Technical Bulletin, TB MED-251, for the 150 to 300, 300 to 600, 600 to 1200, 1200 to 2400, and 2400 to 4800 cycles per second frequency bands, reference Figure 2.

The noise level for the 5000-Btu/hr capacity refrigeration unit with the open exhaust exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 150 to 300, 300 to 600, 600 to 1200, 1200 to 2400, 2400 to 4800, and 4800 to 10,000 cycles per second frequency bands, reference Figure 3.

The noise level of the 5000-Btu/hr capacity refrigeration unit with the open exhaust and each of two acoustical materials exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 300 to 600, 600 to 1200, 1200 to 2400, and 2400 to 4800 cycles per second frequency bands, reference Figure 3.

The noise level for the 5000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1066 and with the Nelson Muffler and each of two acoustical materials exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251 for the 300 to 600, 600 to 1200, 1200 to 2400 and 2400 to 4800 cycles per second frequency bands, reference Figure 4.

The noise level for the 5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1416 and with the Hapco M39-1416 Muffler and each of two acoustical materials exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 300 to 600, 600 to 1200, 1200 to 2400, and 2400 to 4800 cycles per second frequency bands, reference Figure 5.

The noise level for the 5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1-S1 and with the Hapco Muffler M39-1-S1 and each of two acoustical materials exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 150 to 300, 300 to 600, 600 to 1200, 1200 to 2400, 2400 to 4800 cycles per second frequency bands, reference Figure 6.

The noise level for the 9000-Btu/hr capacity refrigeration unit with the Onan Muffler exceeded the limits specified in the Department of the Army Technical Bulletin, TB MED-251, for the 300 to 600, 600 to 1200, and 1200 to 2400 cycles per second frequency bands, reference Figure 7.

7. Summary:

The following refrigeration units in the configuration specified exceeded the 90-dBC acceptable maximum noise level at the operator's position in the Department of the Army Technical Bulletin, TB MED-251, Noise and Conservation of Hearing:

- 3000-Btu/hr capacity refrigeration unit with open exhaust.
- 5000-Btu/hr capacity refrigeration unit with open exhaust.
- 9000-Btu/hr capacity refrigeration unit with the Onan Muffler.
- 3000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1066.
- 3000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1416.
- 5000-Btu/hr capacity refrigeration unit with the open exhaust and TEC-200 BF acoustical material.
- 5000-Btu/hr capacity refrigeration unit with the open exhaust and TEC-100 acoustical material.
- 5000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1066.
- 5000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1066 and TEC-200 BF acoustical material.

5000-Btu/hr capacity refrigeration unit with the Nelson Muffler 1066 and TEC-100 acoustical material.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1416.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1416 and TEC-200 BF acoustical material.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1416 and TEC-100 acoustical material.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1-S1.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1-S1 and TEC-200 BF acoustical material.

5000-Btu/hr capacity refrigeration unit with the Hapco Muffler M39-1-S1 and TEC-100 acoustical material.

The addition of either a Nelson Muffler 1066 or a Hapco Muffler M39-1416 to the 3000-Btu/hr capacity refrigeration unit decreased the noise level at the operator's position from 101 dBC to 100 dBC.

The addition of a Nelson Muffler 1066, a Hapco Muffler M39-1416, and a Hapco Muffler M39-1-S1 to the 5000-Btu/hr capacity refrigeration unit decreased the noise level from 102 dBC to 100 dBC and 101 dBC, only.

The addition of an acoustical material to the 5000-Btu/hr capacity refrigeration unit with an open exhaust or with a specific muffler reduced the noise level by one decibel in four instances, did not make any change in three instances, and caused an increase of one decibel in one instance.

The addition of any of the three mufflers to either the 3000-Btu/hr capacity refrigeration unit or the 5000-Btu/hr capacity refrigeration unit increased the back pressure in the exhaust manifold from the specification requirement of eight inches of water.

8. Conclusions:

It is concluded that:

a. The noise level at the operator's position for the 3000-Btu/hr capacity refrigeration unit exceeded the 90-dBC noise level requirement of Military Specification MIL-R-43031D.

b. The noise level at the operator's position for the 5000-Btu/hr capacity refrigeration unit exceeded the 90-dBC noise level requirement of Military Specification MIL-R-12574F.

c. The noise level at the operator's position for the 9000-Btu/hr capacity refrigeration unit exceeded the 90-dBC maximum allowable noise level specified in the Department of the Army Technical Bulletin TB MED-251.

d. The addition of a muffler and acoustical material, either singly or in combination, will not reduce the noise level at the operator's position for either the 3000-Btu/hr capacity refrigeration unit or the 5000-Btu/hr capacity refrigeration unit to the acceptable maximum noise level limit of 90-dBC.

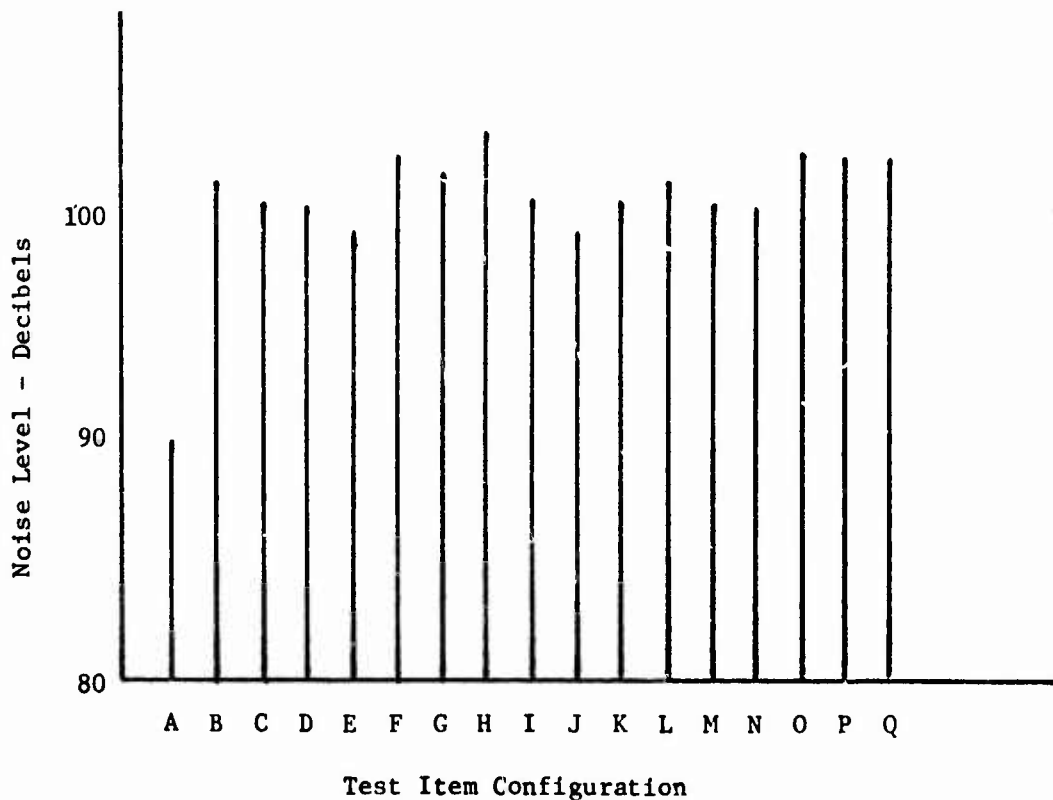
e. The noise level at the operator's position for the 3000-Btu/hr capacity refrigeration unit, the 5000-Btu/hr capacity refrigeration unit and the 9000-Btu/hr capacity refrigeration unit far exceeds the level which reportedly can cause impairment of hearing.

REFERENCES

1. Military Specification MIL-R-43031, Refrigeration Units, Mechanical, Panel Type, 3000-Btu/hr Capacity
2. Military Standard MIL-STD-279, Compressor, Reciprocating, Power-driven, Open-Type, for use with Refrigerant-12
3. Military Specification MIL-R-43024, Refrigerator, Mechanical, Commercial, Portable, Reach-in, 70 Cubic Foot
4. Military Specification MIL-R-12574, Refrigeration Unit, Mechanical, Panel Type for Refrigerator, Portable, 150 Cubic Foot
5. Military Specification MIL-R-12571, Refrigerator, Mechanical, Commercial, Field, Portable, Walk-in, Plug-in (150 Cubic Foot)
6. Military Specification MIL-R-10735, Refrigeration Units, Mechanical, Panel Type, Gasoline Engine and Electric Motor Driven, for Semi-Trailer Refrigerators
7. Military Specification MIL-E-11275, Engine, Gasoline, Industrial Type, General Specification for
8. Military Specification MIL-S-62034, Semitrailer, Van, and Semitrailer, Refrigerator, Military Design
9. Department of the Army Technical Bulletin TB MED-251, Noise and Conservation of Hearing

APPENDIX A

Noise Level Comparison at Operator's Position
and
Octave Band Curves



- A. Maximum specified by Surgeon General
- B. 3000 Btu/hr Refrigeration Unit, Open Exhaust
- C. 3000 Btu/hr Refrigeration Unit with Nelson 1066 Muffler
- D. 3000 Btu/hr Refrigeration Unit with Hapco M39-1416 Muffler
- E. 9000 Btu/hr Refrigeration Unit with Onan Muffler
- F. 5000 Btu/hr Refrigeration Unit with Open Exhaust
- G. 5000 Btu/hr Refrigeration Unit with Open Exhaust and
TEC-200 BF Acoustical Material
- H. 5000 Btu/hr Refrigeration Unit with Open Exhaust and
TEC-100 Acoustical Material
- I. 5000 Btu/hr Refrigeration Unit with Nelson 1066 Muffler
- J. 5000 Btu/hr Refrigeration Unit with Nelson Muffler and
TEC-200 BF Acoustical Material
- K. 5000 Btu/hr Refrigeration Unit with Nelson Muffler and
TEC-100 Acoustical Material
- L. 5000 Btu/hr Refrigeration Unit with Hapco M39-1416 Muffler
- M. 5000 Btu/hr Refrigeration Unit with Hapco M39-1416 Muffler and
TEC-200 BF Acoustical Material
- N. 5000 Btu/hr Refrigeration Unit with Hapco M39-1416 Muffler and
TEC-100 Acoustical Material
- O. 5000 Btu/hr Refrigeration Unit with Hapco M39-1-S1 Muffler
- P. 5000 Btu/hr Refrigeration Unit with Hapco M39-1-S1 Muffler and
TEC-200 BF Acoustical Material
- Q. 5000 Btu/hr Refrigeration Unit with Hapco M39-1-S1 Muffler and
TEC-100 Acoustical Material

Figure 1. Noise Level Comparison at Operator's Position

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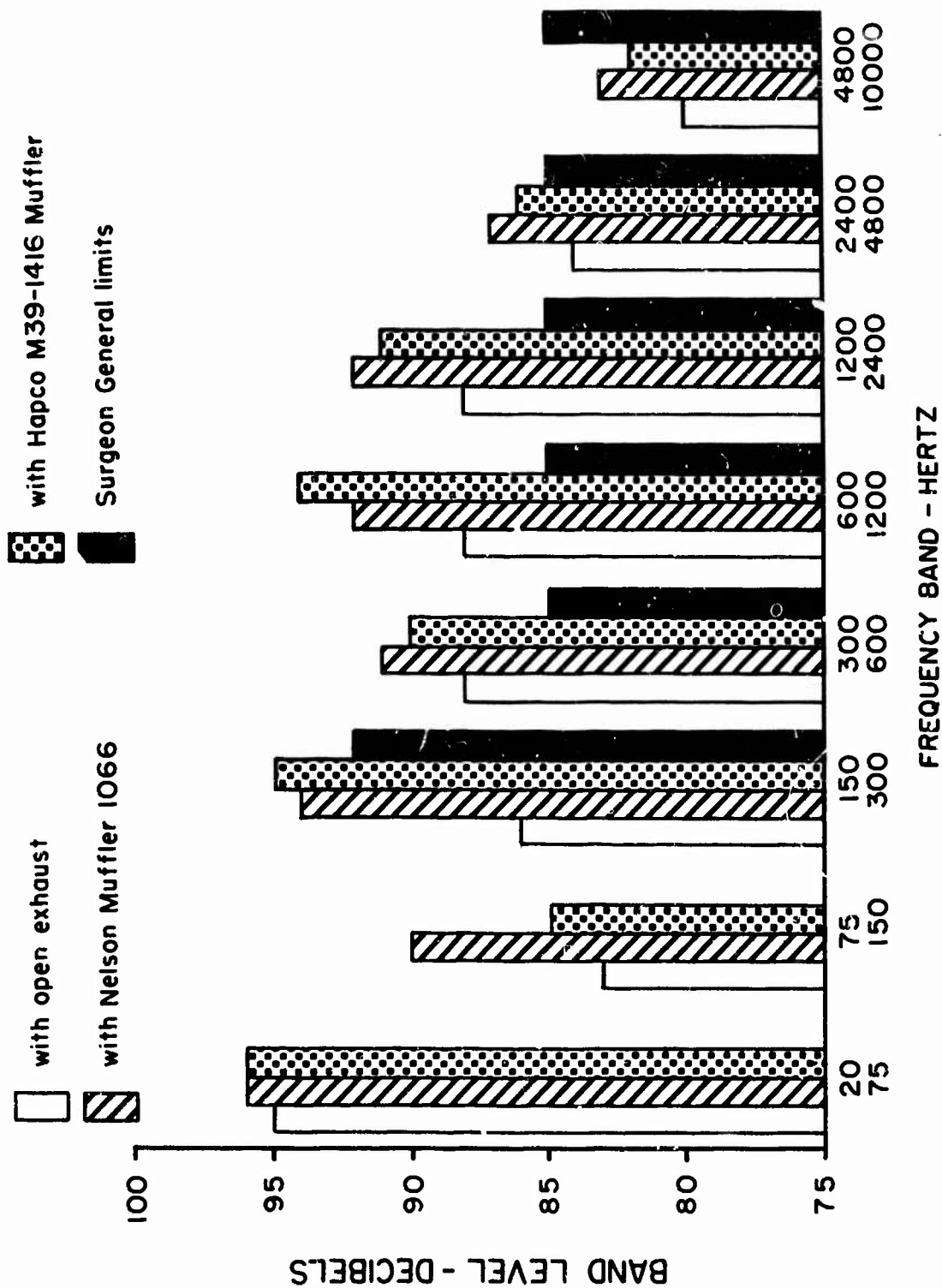


FIGURE 2

OCTAVE BAND CURVES
3000 BTU/HR CAPACITY REFRIGERATION UNIT

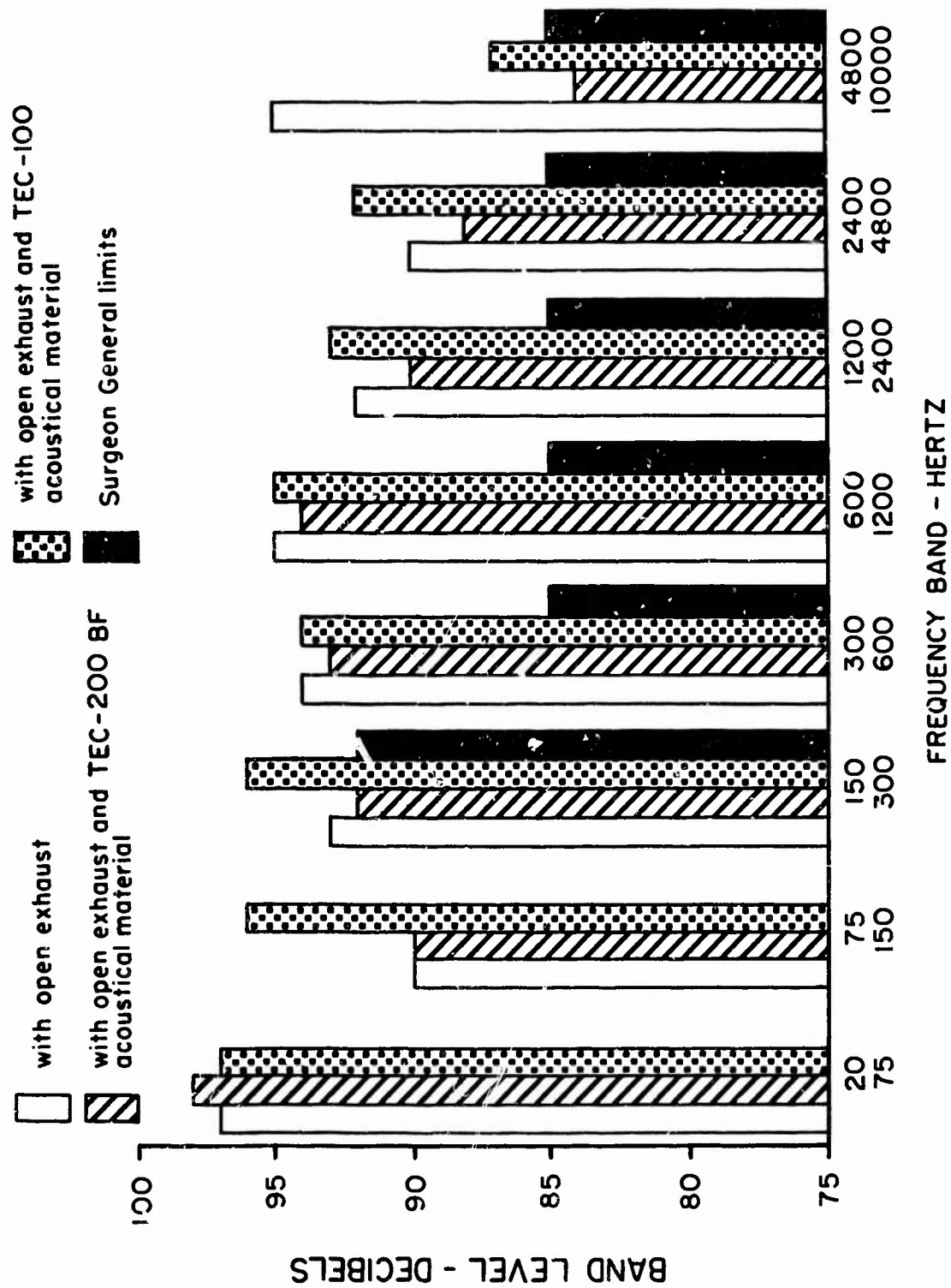


FIGURE 3

OCTAVE BAND CURVES
5000 BTU/HR CAPACITY REFRIGERATION UNIT

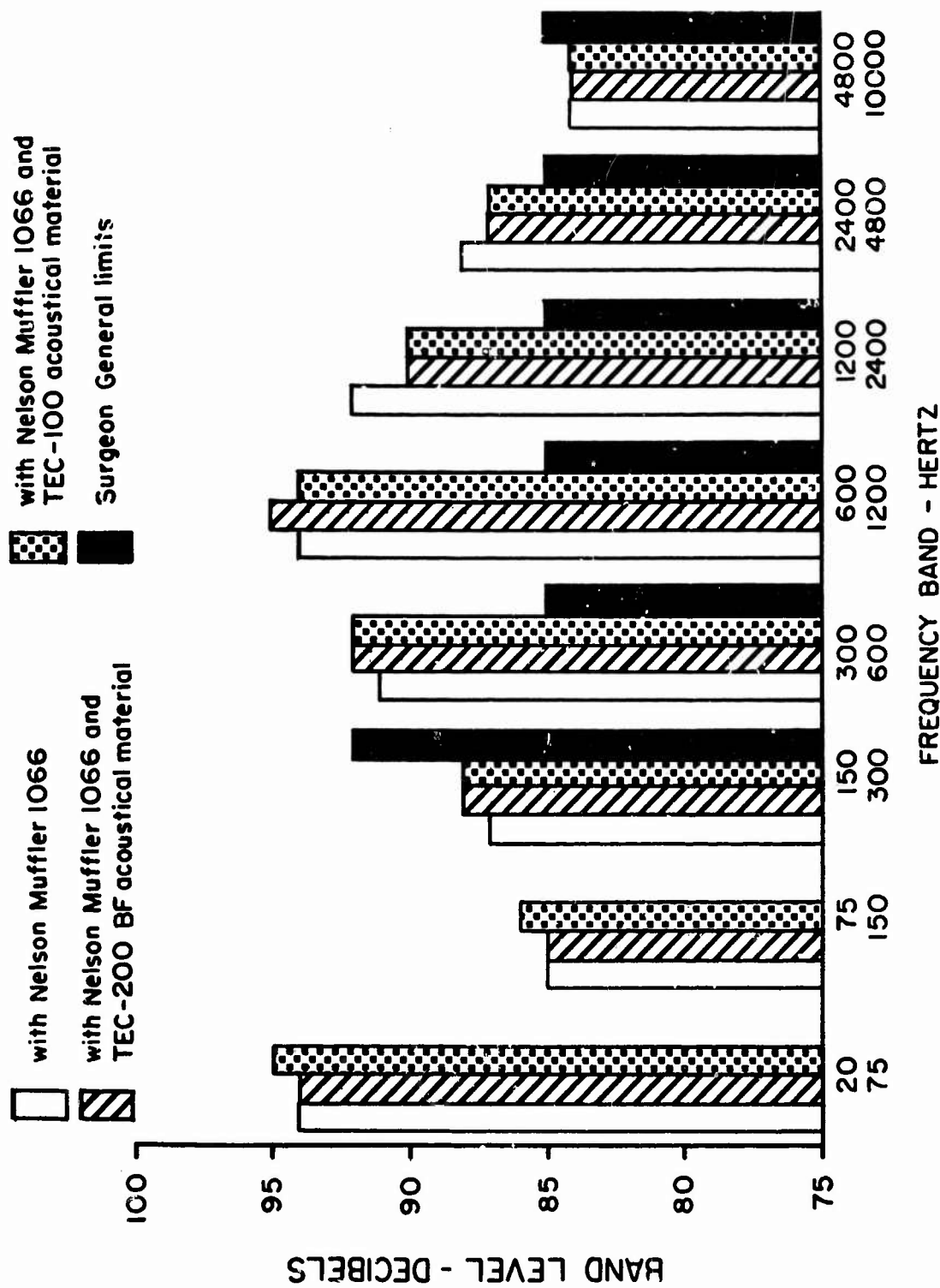


FIGURE 4

OCTAVE BAND CURVES
5000 BTU/HR CAPACITY REFRIGERATION UNIT

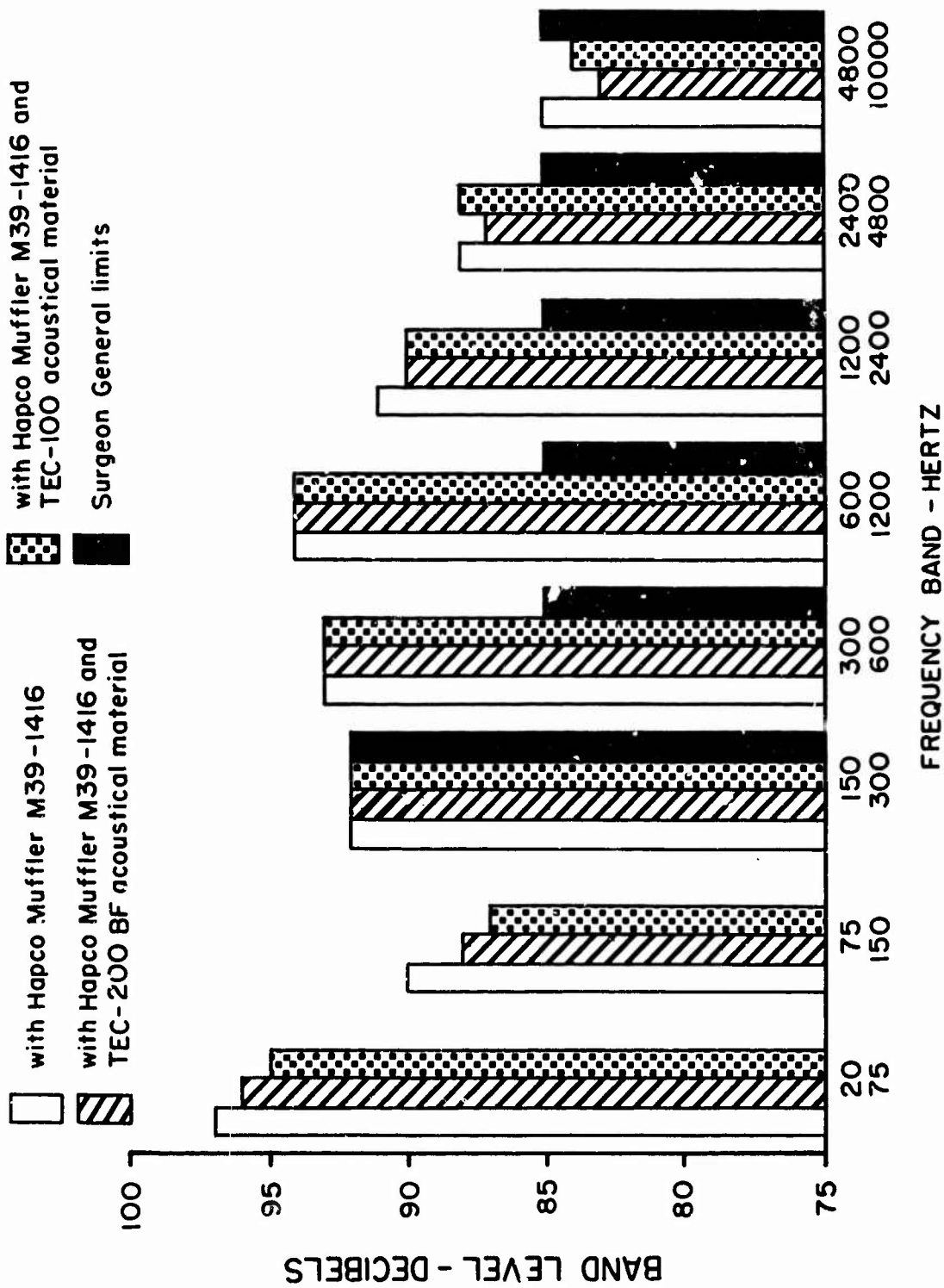


FIGURE 5

OCTAVE BAND CURVES
5000 BTU/HR CAPACITY REFRIGERATION UNIT

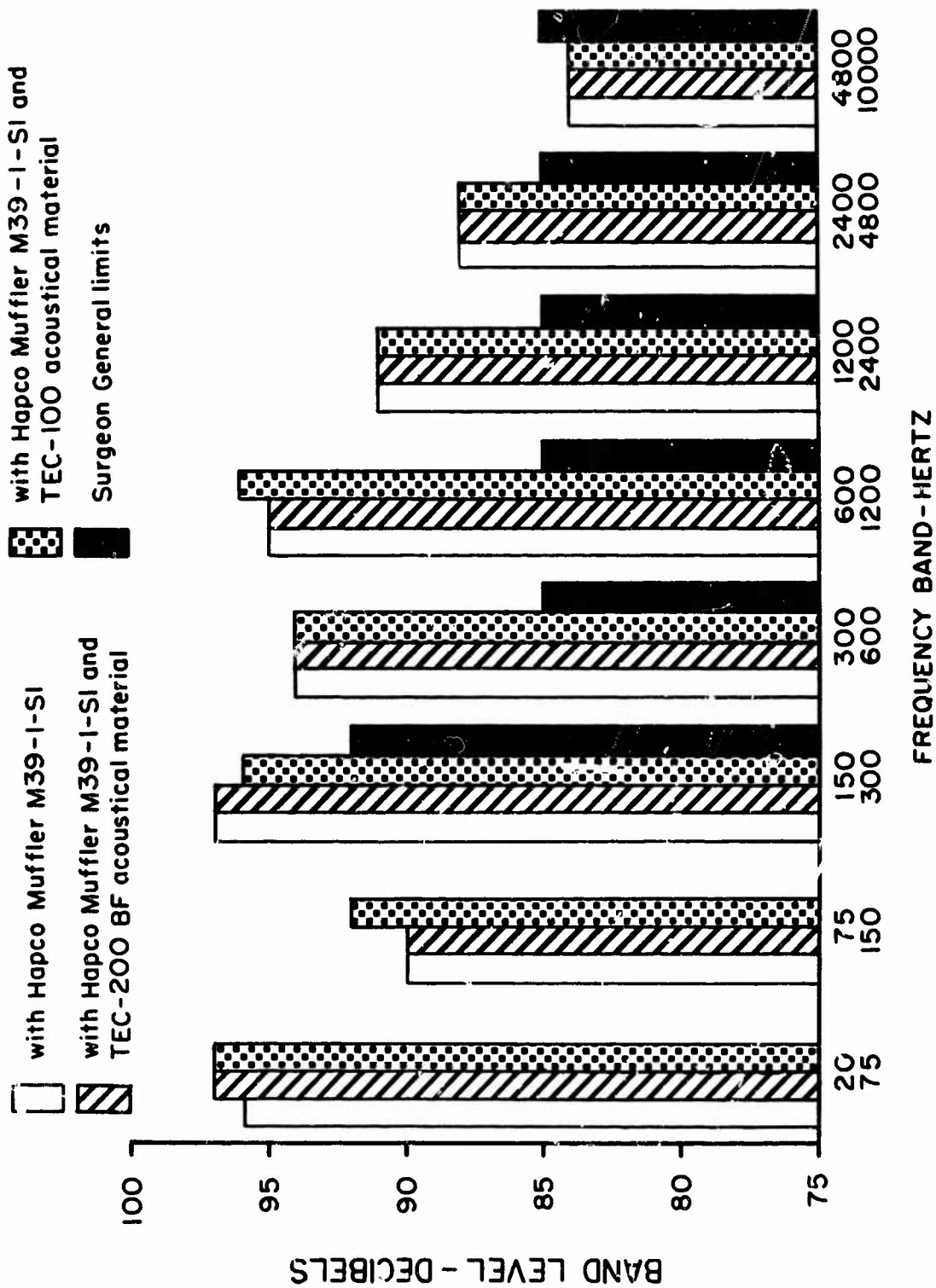


FIGURE 6

OCTAVE BAND CURVES
5000 BTU/HR CAPACITY REFRIGERATION UNIT

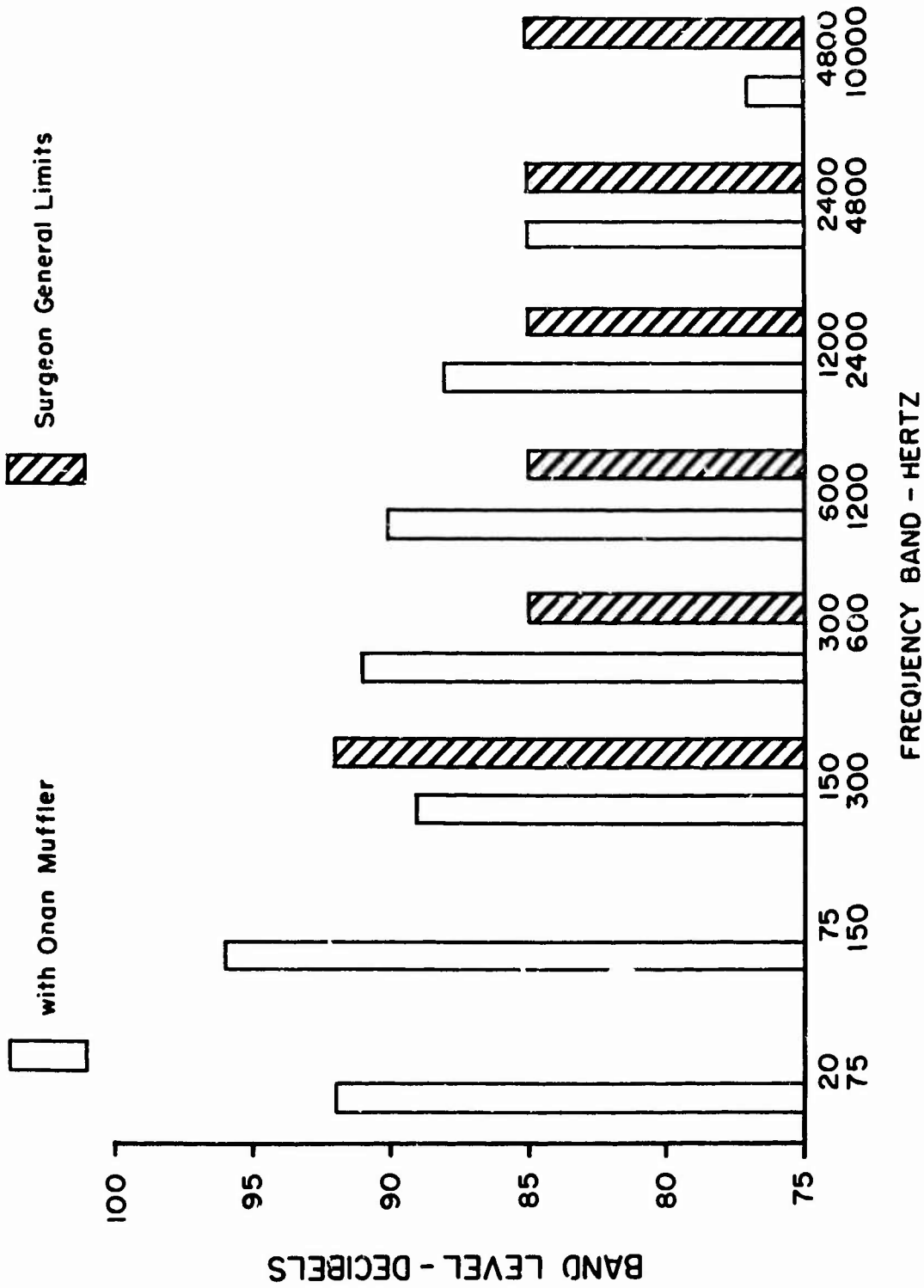


FIGURE 7

OCTAVE BAND CURVES
9000 BTU/HR CAPACITY REFRIGERATION UNIT

APPENDIX B

Test Result Tables

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TABLE I

Test Results for the 3000 Btu/hr Capacity Refrigeration Unit

	WITH OPEN EXHAUST	WITH NELSON 1066 MUFFLER	WITH HAPCO M39-1416 MUFFLER
Back Pressure in Exhaust Manifold (inches of water)	4	22.5	28
Noise Level at Operator's Position (dBC)	101	100	100
Distance for 90 dBC Noise Level			
Front	20'	10' 3"	11' 9"
Left	14' 10"	9' 10"	10' 9"
Right	8' 10"	3' 7"	11"
Band Noise Level (dBC) at operator's position			
30-75 cps	95	96	96
75-150 cps	83	90	85
150-300 cps	86	94	95
300-600 cps	88	91	90
600-1200 cps	88	92	94
1200-2400 cps	88	92	91
2400-4800 cps	84	87	86
4800-10,000 cps	80	83	82

NOTE: Surgeon General's limits for octave band noise levels are stated in "C" scale values.

TABLE II

Test Results for the 5000 Btu/hr Capacity Refrigeration Unit

	WITH OPEN EXHAUST	WITH NELSON MUFFLER	WITH HAPCO M39-1416 MUFFLER	WITH HAPCO M39-1-S1 MUFFLER
Back Pressure in Exhaust Manifold (inches of water)	2	22	26	13
Noise Level at Operator's Position (dBC)	102	100	101	102
Distances for 90 dBA Noise Level				
Front	20' 2"	16'	11' 3"	21' 7"
Left	11'	11' 1"	13' 2"	15' 3"
Right	16' 9"	8'	9'	9' 9"
Band Noise Level (dBC) at operator's position				
20-75 cps	97	94	97	96
75-150 cps	90	85	90	90
150-300 cps	93	87	92	97
300-600 cps	94	91	93	94
600-1200 cps	95	94	94	95
1200-2400 cps	92	92	91	91
2400-4800 cps	90	88	88	88
4800-10,000 cps	85	84	85	84

NOTE: Surgeon General limits for octave band noise levels are stated in "C" scale values.

TABLE III

Test Results for the 5000 Btu/hr Capacity Refrigeration Unit

WITH OPEN EXHAUST AND TEC-100		WITH OPEN EXHAUST AND TEC 200 BF	
ACOUSTICAL MATERIAL		ACOUSTICAL MATERIAL	
Noise Level at Operator's Position (dBC)	103	101	
Distances of 90 dBA Noise Level			
Front	18' 5"	20' 3"	
Left	9' 3"	10' 9"	
Right	12' 3"	18' 8"	
Band Noise Level (dBC) at operator's position			
20-75 cps	97	98	
75-150 cps	96	90	
150-300 cps	96	92	
300-600 cps	94	93	
600-1200 cps	95	94	
1200-2400 cps	93	90	
2400-4800 cps	92	88	
4800-10,000 cps	87	84	

NOTE: Surgeon General limits for octave band noise levels are stated in "C" scale values.

TABLE IV

Test Results for the 5000 Btu/hr Capacity Refrigeration Unit

	WITH NELSON MUFFLER 1066 AND TEC-100 ACOUSTICAL MATERIAL	WITH NELSON MUFFLER 1066 AND TEC 200 BF ACOUSTICAL MATERIAL
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Noise Level at Operator's Position
(dBC)

100

99

Distance of 90 dBA Noise Level

Front
Left
Right

12' 3"
12'
7'

10' 5"
9' 9"
6' 4"

Band Noise Level (dBC) at operator's position

20-75 cps
75-150 cps
150-300 cps
300-600 cps
600-1200 cps
1200-2400 cps
2400-4800 cps
4800-10,000 cps

95
86
88
92
94
90
87
84

94
85
88
92
95
90
87
84

NOTE: Surgeon General limits for octave band noise levels
are stated in "C" scale values.

TABLE V

Test Results for the 5000 Btu/hr Capacity Refrigeration Unit

WITH HAPCO M39-1416 MUFFLER AND TEC-100 ACOUSTICAL MATERIAL		WITH HAPCO M39-1416 MUFFLER AND TEC 200 BF ACOUSTICAL MATERIAL	
Noise Level at Operator's Position (dBC)	100	Noise Level at Operator's Position (dBC)	100
Distance of 90 dBA Noise Level			
Front	11' 5"	12' 3"	
Left	11' 3"	15' 1"	
Right	9' 6"	8' 5"	
Band Noise Level (dBC) at operator's position			
20-75 cps	95	96	
75-150 cps	87	88	
150-300 cps	92	92	
300-600 cps	93	93	
600-1200 cps	94	94	
1200-2400 cps	90	90	
2400-4800 cps	88	87	
4800-10,000 cps	84	83	

NOTE: Surgeon General limits for octave band noise levels are stated in "C" scale values.

TABLE VI

Test Results for the 5000 Btu/hr Capacity Refrigeration Unit

		WITH HAPCO M39-1-S1 MUFFLER AND TEC-100 ACOUSTICAL MATERIAL	WITH HAPCO M39-1-S1 MUFFLER AND TEC 200 BF ACOUSTICAL MATERIAL
Noise Level at Operator's Position (dBC)	102	102	102
Distance of 90 dBA Noise Level			
Front	16' 4"	18' 7"	
Left	11' 3"	13' 1"	
Right	11' 4"	11' 5"	
Band Noise Level (dBC) at operator's position			
20-75 cps	97	97	97
75-150 cps	92	92	90
150-300 cps	96	96	97
300-600 cps	94	94	94
600-1200 cps	96	96	95
1200-2400 cps	91	91	91
2400-4800 cps	88	88	88
4800-10,000 cps	84	84	84

NOTE: Surgeon General limits for octave band noise levels are stated in "C" scale values.

TABLE VII

Test Results for the 9000 Btu/hr Capacity Refrigeration Unit

WITH ONAN MUFFLER

Noise Level at Operator's Position (dBC)	99
Distance of 90 dBC Noise Level	
Front	9'
Left	6'
Right	9' 6"
Band Noise Level (dBC) at operator's position	
20-75 cps	92
75-150 cps	96
150-300 cps	89
300-600 cps	91
600-1200 cps	90
1200-2400 cps	88
2400-4800 cps	85
4800-10,000 cps	77

NOTE: Surgeon General limits for octave
band noise levels are stated in
"C" scale values.